Battery-Charging Stations

by David Corbus and Vahan Gevorgian 12/99

Background

Getting their electrical service by charging 12-volt, 50–100 Ah batteries from diesel grids is common for residents in some areas of the developing world. However, a few examples of renewable-energy-powered battery-charging stations also exist in such areas. For example, GTZ, a German company, installed a photovoltaic (PV) battery-charging station in the Philippines, and the National Renewable Energy Laboratory (NREL) is deploying a PV-powered battery-charging station in India.

Transport of the batteries to and from the household is either the responsibility of the resident or a service provided by the station. The batteries can be individually owned or leased from the station. The batteries are charged either on a set schedule or as the batteries need a recharge. Although such logistical variables provide a challenge, battery-charging stations have the major advantage of bringing affordable electric service to very-low-income populations.

Status

NREL has studied the institutional arrangements for battery-charging stations, and conducted research, both design and testing, on their architecture and controls. As part of the deployment of a PV-powered battery-charging station in India, NREL tested a PV-powered battery-charging station (identical to the one in India) provided by Applied Power Corporation. Initial testing has been completed and results are available (see Contacts).

Significant research has also been conducted on wind power for battery-charging stations. Because of the variable-voltage DC bus typical of small wind turbines, the design of a wind-powered battery-charging station can be complex. Yet, there is potentially a greater economy of scale for a wind-powered station when compared with a PV station.

Testing at NREL on wind-powered battery-charging stations has focused on a low-cost method for charging 12-volt, deep-cycle batteries from a small wind turbine. Three alternatives were evaluated. The first option has four batteries, with a common state of charge, in series with many strings in parallel and voltage control for the entire DC bus. The second has individual charging control for each 12-volt battery using a DC-to-DC converter/charger for each battery. The third option is an AC minigrid system comprising batteries and an inverter under which the battery charging load is only one of many various village loads on the system.

NREL has completed feasibility testing of a wind-powered battery-charging station using the second alternative and has awarded a contract to Ascension Technology for the production, design, and fabrication of a commercial prototype based on the testing.

The BCS-1 battery-charging unit, developed by Ascension Technology, is a 200-watt power converter that has been primarily designed to operate from the three-phase AC output of the wind turbine. It has a three-phase full-bridge rectifier to receive input power and convert that to DC. It has a DC/DC buck converter operating in current program mode control, controlling output voltage and current. It is a microprocessor-controlled device that controls the power level at which the converter operates. It has a voltage trim adjustment that can be used to set the maximum output voltage of the unit from 0 to 16 V DC, and a current trim adjustment that can be used to set the maximum output current of the unit from 0 to 14 amps DC. The BCS-1 also has several features to protect itself and batteries from overvoltage and overcurrent conditions.

Multiple BCS-1 units may be connected to a single power source to build battery-charging stations of any size, limited only by the power and energy availability of the wind turbine. BCS-1 units may be co-located or distributed, so long as three-phase power is provided from the power source.

The prototype battery-charging, station-based BCS-1 units are powered by a 3-kW wind turbine that has been successfully tested at NREL.

Issues with Wind-powered Battery-Charging Stations

NREL researchers discussed issues on the Internet with researchers and renewable energy experts worldwide. The discussion dealt with several key issues, including the operational, technical, financial, environmental, and safety aspects of battery-charging stations. The discussion group proposed that batteries could either be owned by the station and leased to the user or be owned by the user. The lease system has several benefits:

- Standardization of the batteries
- Cost leverage from bulk purchase
- Weekly maintenance at a station.

On the other hand, an individual ownership system has one, very key, benefit. The individual is responsible for their own battery maintenance and, therefore, is less likely to over-discharge the battery.

The group also expressed concern that batteries could be easily mishandled if the end user was responsible for transport. Such mishandling could result in shortened battery life and possible battery-acid spills resulting in personal injury. An alternative is to have a transportation service such as a donkey cart, a truck, or another mode of local transportation. Although this option is more expensive, it may be more economical in the long run because of better battery handling, battery throughput control, and increased business generated by a larger service territory.

The environmental and safety issues revolved around recycling and packaging. Recycling is a vital component of all battery programs. A station can probably facilitate recycling because it is a single facility to collect batteries, and because it can deal in bulk with battery recyclers. Safe packaging of batteries has started in South Africa and Brazil. Replication will be necessary for new battery-charging schemes. Concerning financing, the group response suggested a centralized business scenario. A centralized business can provide credit history and is more likely to be approved for a loan than several hundred individual PV users; cost recovery is with a single point of contact. High up-front costs are the limiting factor for complete solar home systems in some communities. In these cases, battery-charging stations hold a critical advantage because there is low or no capital expenditure for the end user.

Planned Activities

Activities for the future include field testing of a commercial prototype battery-charging station built by Ascension Technology, followed by deployment of demonstration pilot projects in the developing countries.

References

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